

WHAT IS CLAIMED IS:

1     1.     A linear fluid motor having a stationary cylinder and a piston movable therein  
2     between end positions by selectively introducing or evacuating via a first port through a  
3     wall of the cylinder a pressurized fluid into or from a first variable volume of the cylinder  
4     on a first side of the piston and simultaneously evacuating or introducing via a second  
5     port through a wall of the cylinder pressurized fluid from or into a second variable  
6     volume of the cylinder on a second side of the piston, comprising:  
7         means carried by and movable with the piston for restricting the introduction or  
8     evacuation of the fluid through either port as long as the piston is located at or less than a  
9     selected distance from one of its end positions to thereby limit the velocity of the piston  
10    during that time.

1     2.     A fluid motor as in Claim 1, wherein the restricting means comprises:  
2         seals that define between the wall of the cylinder and the piston first and second  
3     fixed-volume chambers movable with the piston; and  
4         first and second restrictive orifices, the first orifice interconnecting the first  
5     chamber with the first variable volume, the second orifice interconnecting the second  
6     chamber with the second variable volume;  
7         the ports and the orifices being so related that, when the piston is located at or less  
8     than a selected distance away from the associated end position, the fluid that is  
9     introduced or evacuated into or from the associated variable volume enters or leaves the  
10    associated chamber and thereafter enters or leaves the associated variable volume via the  
11    associated restrictive orifice.

1 3. A fluid motor as in Claim 2, wherein each fixed-volume chamber communicates  
2 with its associated port only while the piston is located at or less than the selected  
3 distance away from the associated end position.

1 4. A fluid motor as in Claim 3, wherein the fixed-volume chambers have a  
2 dimension parallel to the direction of movement of the piston that is equal to the selected  
3 distance.

1 5. A fluid motor as in Claim 2, wherein:  
2 as the piston moves, the fixed-volume chambers move therewith; and  
3 each port communicates with its associated moving chamber until the chamber  
4 has moved therepast.

1 6. A fluid motor as in Claim 5, wherein the fixed-volume chambers have a  
2 dimension parallel to the direction of piston movement that is equal to the selected  
3 distance.

1 7. A fluid motor as in Claim 6, wherein the ports are shaped so that as the fixed-  
2 volume chambers move into and out of communication therewith the rate of fluid  
3 movement into or out of the chambers changes gradually.

1 8. A fluid motor as in Claim 7, wherein the ports are elongated in the direction of  
2 movement of the fixed-volume chambers.

1 9. A fluid motor as in Claim 8, wherein the elongation of the ports is tapered.

- 1    10.    A fluid motor as in Claim 9, wherein the ports have a rhomboid cross-section.
- 1    11.    A fluid motor as in Claim 1, wherein the velocity of the piston versus its position
- 2    in the cylinder is as depicted in Figure 6.

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12. A linear fluid motor having a piston within a close-ended cylinder, wherein the piston, the cylinder sidewall and the cylinder ends divide the cylinder into two variable volumes, the piston and the cylinder being relatively movable between first and second rest positions by selectively introducing a fluid through a first port into one of the variable volumes and simultaneously evacuating fluid through a second port from the other variable volume, comprising:

means carried by and movable with the piston (i) for restricting the introduction of the fluid into the one variable volume while the piston-cylinder is in the first rest position and until there has occurred a selected amount of relative movement out of the first rest position, (ii) for restricting the exhaustion of the fluid from the other variable volume until there can occur a selected amount of relative movement into the second rest position and while the piston-cylinder is in the second rest position, and (iii) for otherwise permitting unrestricted flow of the fluid into or out of the variable volumes to limit the velocity of the relative movement near the end positions.

13. A fluid motor as in Claim 12, wherein the restricting and permitting means comprises:

piston-carried seals that define between the cylinder and the piston first and second fixed-volume chambers movable with the piston; and

first and second restrictive orifices, the first orifice interconnecting the first chamber with the first variable volume, the second orifice interconnecting the second chamber with the second variable volume,

the ports and the orifices being so related that, when the end positions are achieved and when the selected amount of relative movement has occurred or can occur,

10 the fluid that is introduced or evacuated into or from the variable volume enters or leaves  
11 the associated chamber and thereafter enters or leaves the associated variable volume via  
12 the associated restrictive orifice.

1 14. A fluid motor as in Claim 13, wherein the velocity of the piston relative to the  
2 cylinder versus its position relative to the cylinder is as depicted in Figure 4.

1 15. A fluid motor as in Claim 13, wherein the velocity of the piston relative to the  
2 cylinder versus its position relative to the cylinder is as depicted in Figure 6.

1 16. A fluid motor as in Claim 12, wherein the restricting and permitting means  
2 comprises:  
3 seals located on the cylinder wall that define between the cylinder and the piston  
4 first and second fixed-volume chambers movable with the piston; and  
5 first and second restrictive orifices, the first orifice interconnecting the first  
6 chamber with the first variable volume, the second orifice interconnecting the second  
7 chamber with the second variable volume,  
8 the ports and the orifices being so related that, when the end positions are  
9 achieved and when the selected amount of relative movement has occurred or can occur,  
10 the fluid that is introduced or evacuated into or from the variable volume enters or leaves  
11 the associated chamber and thereafter enters or leaves the associated variable volume via  
12 the associated restrictive orifice.